Health Consultation

HEAVY METALS IN BARRY COUNTY
BARRY COUNTY, MISSOURI

EPA FACILITY ID: MON000705447

Prepared by the
Missouri Department of Health and Senior Services

SEPTEMBER 24, 2009

Prepared under a Cooperative Agreement with the
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

A health consultation is a verbal or written response from ATSDR or ATSDR's Cooperative Agreement Partners to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR or ATSDR's Cooperative Agreement Partner which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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Missouri Department of Health and Senior Services
Division of Community and Public Health
Section for Disease Control and Environmental Epidemiology
Bureau of Environmental Epidemiology
Under a Cooperative Agreement with the
U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry (ATSDR)

STATEMENT OF ISSUES

The Missouri Department of Health and Senior Services (DHSS), in cooperation with the federal Agency for Toxic Substances and Disease Registry (ATSDR), has completed this health consultation at the request of the Missouri Department of Natural Resources (DNR). This health consultation provides a review and comments on the soil and water sampling conducted by DNR within Barry County on November 20, 2008 and February 20, 2009. This health consultation addresses whether there are increased health risks to local residents that can be attributed to metal contaminants in soil and water.

BACKGROUND

Site Description and History

Missouri has a rich history of lead mining dating back to the 1700s. Mining began along the Meramac River and in the St. Francois Mountains in the southeast part of the state, and then expanded throughout the southern half of the state as new lead deposits were discovered. Studies have shown that residential exposure to mining, milling, and smelting wastes around these locations is related to an increased percentage of children with elevated blood lead levels (1, 2). Because of the findings of these studies, DHSS recommends soil sampling of residential properties around mining areas.

For the past several years, DNR, along with the U.S. Environmental Protection Agency (EPA), has been conducting a statewide inventory of lead mining, milling, and smelting sites in Missouri. One of these former mining areas is Barry County, which is located in the southwest corner of Missouri.

On January 6, 2006, EPA collected a water sample from a private well located in Barry County near a known former mining location and found lead at a concentration of 21.1 micrograms per liter (µg/L). This exceeds EPA's action level of 15 µg/L for lead in drinking water. EPA returned on April 8, 2006 to retest this well and found lead at a concentration of 11 µg/L. On April 8, 2006, EPA also collected a water sample from a nearby spring and found a lead concentration of 247 µg/L. Because of EPA's findings and based on the number of known mines in the area catalogued on DNR's Inventory of Mines, Occurrences, and Prospects (IMOP) database, DNR began planning for sampling of water from private wells and soil from residential yards near this area.

On November 20, 2008, DNR sampled 13 private drinking water wells and the spring EPA had found elevated for lead previously. One well had a lead level of 30.2 µg/L; all other wells were less than 15 µg/L. DNR returned to Barry County on February 20, 2009 to retest this well and found a lead level of 32.4 µg/L; however, when DNR tested the water at the tap, the lead level was less than 1 µg/L. This was most likely due to a water filter that had been installed by the resident at the kitchen tap after the first sampling event.

Another well was found to have elevated levels of cadmium in November 2008 with a cadmium level of 13.3 µg/L. This level of cadmium exceeds EPA's Maximum Contaminant Level (MCL) for cadmium of 5 µg/L, which is the highest level allowed in public water systems. This level of cadmium also exceeds ATSDR's Environmental Media Evaluation Guide (EMEG) for cadmium of 1 µg/L for a child and 4 µg/L for an adult when the exposure lasts for a year or more. In February 2009, DNR resampled this location and found a cadmium level of 7.7 µg/L at the wellhead and 7.2 µg/L at the tap.

During DNR's sampling, they tested the spring water that EPA found elevated in 2006. DNR has now sampled this spring water twice and have not detected elevated levels of lead. DNR also reports that this spring is currently not being used as a residential drinking source.

While collecting water samples, DNR also conducted soil testing in 7 residential yards. Soil sample results were compared to the EPA standard residential screening level for lead of 400 ppm. See Lead Values for Soil under the Toxicological Evaluation section for an explanation of the lead values used. On November 20, 2008, DNR found one yard that exceeded 400 ppm of lead in the soil. The average lead concentration in the soil of this yard was 689 ppm with the highest concentration being 2,574 ppm lead. In order to better determine if the elevated lead concentrations may be due to lead-based paint on the house, DNR returned to the property on February 20, 2009 to conduct further soil sampling. These samples were collected further away from the house to reduce the influence of lead-based paint on the samples. The soil samples collected in February 2009 had an average lead concentration of 348 ppm with the highest concentration found being 656 ppm.

DISCUSSION

The exposure pathway of concern for Barry County residents with elevated cadmium in their private drinking water is through ingestion (swallowing) of cadmium contaminated water in the well. Other potential exposure pathways, such as inhalation (breathing) or dermal contact (touching) are expected to be of less concern. Individuals can be exposed to the cadmium in this water through ingestion while drinking and cooking with contaminated water. Individuals may also accidentally ingest contaminated water while bathing and playing in this water.

The level of cadmium DNR found in one well exceeded the EMEG for cadmium. EMEGs are estimated concentrations of chemicals that are not expected to cause adverse noncarcinogenic health effects. Concentrations above EMEGs do not necessarily indicate that a health threat is present, but that further evaluation of the chemical and pathway is needed.

In this case, the exposure dose a child would have drinking water containing cadmium at a level of 7.2 µg/L would be 0.72 micrograms per kilogram per day (µg/kg/day) using the

default values of an 10 kilogram child drinking 1 liter of water a day. See Table 1. This dose would increase to 1.33 µg/kg/day if the water the child is drinking contained 13.3 µg/L of cadmium. The exposure dose an adult would have drinking water containing cadmium at a level of 7.2 µg/L would be 0.206 µg/kg/day using the default values of an 70 kilogram adult drinking 2 liter a day. This adult exposure dose increases to 0.38 µg/kg/day if the level of cadmium in the water is 13.3 µg/L. All of these calculated doses also exceed the ATSDR chronic oral Minimal Risk Level (MRL) of 0.1 µg/kg/day. An MRL is an estimate of the amount of a chemical a person could be exposed to each day for a specific period of time that is not expected to cause adverse noncarcinogenic health effects. For a chronic MRLs, the specific period of time used is one year or more. Concentrations above MRLs do not necessarily indicate that a health threat is present, but that further evaluation of the chemical and pathway is needed.

Table 1. Calculated Doses

Child/Adult Exposure	Level of Cadmium in Water (µg/L)	Estimated Body Weight (kg)	Estimated amount of water ingested each day (L)	Calculated estimate of Cadmium ingested from water each day (µg/kg/day)
Child	7.2	10	1	0.72
Child	13.3	10	1	1.33
Adult	7.2	70	2	0.206
Adult	13.3	70	2	0.38

This means that if a 10 kg (kilogram), approximately 22 pound, child drinks 1 liter (L) of water containing 7.2 micrograms of cadmium per liter of water (µg/L) each day, the child would swallow 0.72 micrograms (µg) of cadmium a day for every kg the child weighs. This is shown by saying 0.72 micrograms per kilogram per day (µg/kg/day).
For an adult that weighs 70 kg, approximately 154 pounds, who drinks 2 liters of water containing 7.2 µg/L of cadmium, they would swallow 0.206 µg/kg/day.

The water was tested at the tap where water is likely to be used for drinking. The estimated exposure dose for a child for this tap water is over seven times greater than the MRL. Also, the level of cadmium found at the tap was over 7 times higher than the EMEG for a child and almost 2 times higher than the EMEG for an adult. Therefore, it is likely that a health risk does exist for individuals who drink this water on a regular basis. Ingestion is a larger exposure factor than inhalation; however, small amounts of cadmium can be inhaled into the lungs when showering in contaminated water.

Individuals, especially children, using water from this well should reduce their exposure to cadmium by drinking bottled water or installing a filtration device rated for reduction or removal of cadmium. Individuals should also avoid activities that may add to their exposure, such as smoking.

DNR found elevated levels of lead in one residential yard in Barry County. Because the highest levels of lead were found near the home, it is likely that the lead contamination is due to lead-based paint from the house instead of mining related activities. The main

pathway for exposure to this soil is through ingestion (swallowing) of lead contaminated soil in the yard. Individuals, especially children, can be exposed to this contaminated soil directly by accidentally ingesting the soil while working, playing, gardening, or spending time in the yard. This contaminated soil can be tracked indoors by shoes, pets and other routes and accumulate in the home. Individuals, especially children, can accidentally ingest this contaminated dust in the home. Although not as major of route as ingestion, individuals can also be exposed to this contaminated soil in the yard and contaminated dust in the home by inhalation. When this soil or dust is stirred up and becomes airborne, individuals, especially children, may breathe it in and absorb the lead through their lungs.

One of the private drinking wells that DNR tested in this area was found to have levels of lead at the wellhead above a level of health concern. The elevated lead concentration detected at this wellhead on November 20, 2008 was confirmed in February 2009 when DNR resampled at the wellhead and found similar results. However, when DNR resampled this well in February 2009, they also collected a water sample from an indoor faucet which had a filter. The lead concentration found at this tap was below a concentration of lead that could be detected by the laboratory (less than 1 µg/L). The exposure pathway of concern for lead in water is through ingestion (swallowing) of the lead contaminated water. Since the primary source of drinking water for this residence is at the filtered tap, adverse health effects are not expected as long as the filter is maintained properly.

EPA tested a spring on April 8, 2006 that had a lead concentration of 247 µg/L. DNR has resampled this spring twice since April 2006 and have not found elevated concentrations of lead. DNR also reports that this spring is not currently being used as a residential drinking source. For these reasons, this spring is not expected to pose a health risk due to lead contamination.

TOXICOLOGICAL EVALUATION

Introduction

This section will discuss the health effects of exposure to specific contaminants found at the site. A discussion of non-cancerous health effects and the possibility of the contaminants causing cancer are evaluated in this section.

Cadmium

Cadmium is a soft, silver-white metal that occurs naturally in the earth's crust. Cadmium is not usually present in the environment as a pure metal, but as a mineral combined with other elements. It is most often present in nature as complex oxides, sulfides, and carbonates in zinc, lead, and copper ores. Cadmium has many industrial uses and is used in consumer products including batteries, pigments, metal coatings, plastics, and some metal alloys. For most people, the largest source of cadmium exposure is through food and/or cigarettes. (3)

Ingestion of high levels of cadmium in contaminated food or water can severely irritate the stomach, leading to vomiting and diarrhea, and sometimes death (3). Cadmium is a cumulative toxicant and ingestion of lower levels for a long period of time can lead to a buildup of cadmium in the kidneys and, possibly, kidney damage (3). The kidney is the main target organ for cadmium toxicity following chronic-duration exposure by oral routes (3). At the levels of cadmium found in the residential private water well, drinking this water for a long period of time may cause a buildup of cadmium in the kidneys.

Cancer

The EPA has classified cadmium as a probable human carcinogen by inhalation based on limited evidence of an increase in lung cancer in humans and evidence of lung cancer in rats (3). Studies on humans and animals ingesting cadmium have not found increases in cancer, although additional research is needed (3). The primary route of exposure to cadmium in a residential private water well is through ingestion; therefore, an increased cancer rate due to inhalation of cadmium is not expected.

Lead

Lead is a naturally occurring metal found in the earth's crust (4). It has no characteristic taste or smell (4). It is mined and processed for use in various industries. Lead is used in some types of batteries, ammunition, ceramic glazes, medical equipment, scientific equipment, and military equipment (4). At one time, lead was used as an additive in gasoline and in paint. Lead from gasoline was released into the air in automotive exhaust and deposited along roadways (4). Houses built before 1978 may contain lead based paint. Lead in the soils in the inner cities is often attributable to lead based paint and leaded gasoline (4).

Lead has no nutritional benefits for humans. Exposure to lead can occur by inhalation or ingestion. Lead is not readily absorbed through the skin, so dermal contact is not an important route of exposure. Lead has the greatest effect on the nervous system, especially in children. Pregnant women can experience complications with their pregnancy ranging from low birth rate to miscarriage if exposed to high concentrations of lead. (4) The primary concern from exposure to lead in Barry County is the effects lead has on the nervous system, especially on children less than 72 months of age. Blood lead testing is key in determining if exposure to lead has occurred.

Lead Value for Soil

Exposure to lead in soil is evaluated by using a biological model that predicts a blood lead concentration that would result from exposure to environmental lead contamination. The modeled blood lead concentration is then compared to the level of concern for blood lead concentrations in children as recommended by the CDC (CDC, 2005). CDC's current blood lead level of concern is10 µg/dL. Using this model, EPA has established a standard cleanup value of 400 ppm for lead in soil using the default parameters in this model (5). The default parameters in the model include many estimated values such as

estimated soil ingestion and time spent outdoors. If the default parameters are found to not be accurate in an area being investigated, the cleanup value used at that site may be different.

The default parameters used in the model may not take into consideration all of an individual's exposure to lead. An individual can be exposed to lead through many sources such as drinking water, lead paint, and other items containing lead including certain toys, jewelry, herbal remedies, Mexican candies, water hoses, and others.

Cancer

While the EPA considers lead to be a probable human carcinogen and the National Toxicity Program (NTP) has determined that lead and lead compounds are reasonably anticipated to be human carcinogens, there have been no studies linking residential ingestion of lead contaminated soil or drinking water with an increase cancer risk (4). Although the American Cancer Society estimates less than half of men and slightly more than a third of women in the United States will develop some form of cancer in their lifetime, the primary health concern for lead in Barry County is not cancer; instead, the primary concern from exposure to lead in Barry County is the effects lead has on the nervous system, especially on children less than 72 months of age (6, 7).

Children's Health

DHSS, along with ATSDR, realize that children are not small adults. Because their bodies are still developing and their behaviors are different, their susceptibility and exposure may be different than adults. Because of this, DHSS has evaluated the health implications for children who may be exposed at this site.

In general, children are more likely than adults to become exposed to contaminants in soil or water. In their daily activities, children have a tendency to have frequent hand-to-mouth contact and introduce non-food items into their mouths. Because children are smaller and their bodies typically absorb more of the contaminants, it usually takes less of a contaminant to cause adverse health effects in children than adults.

The effects of exposure to elevated cadmium levels on children are expected to be similar to the effects on adults. Ingestion of high levels of cadmium in contaminated food or water can severely irritate the stomach, leading to vomiting and diarrhea, and sometimes death. Ingestion of lower levels of cadmium over an extended period of time can lead to buildup in the kidneys, and possibly, kidney damage. (3) At the levels of cadmium found in the residential private water well, drinking this water for a long period of time may cause a buildup of cadmium in the kidneys.

Children are more susceptible to lead poisoning than adults, and children are also more likely to be exposed to lead contaminated materials. Infants and young children can swallow and breathe lead contaminated dirt, dust, or sand while they play on the floor or ground. They can also be exposed to lead through breast milk if the mother has elevated

levels of lead in her system. Also, compared to adults, a larger proportion of the amount of lead swallowed will enter the blood in children (4). While about 99% of the amount of lead taken into the body of an adult will leave as waste within a few weeks, only about 32% of lead taken into the body of a child will leave as waste (4). All of these factors result in children being more affected by lead than adults when they have similar lead concentrations in their environment.

When children are exposed to lead contaminated materials, a variety of adverse health effects can occur depending on the amount of lead to which they are exposed and the duration of exposure. These effects include learning disabilities, slowed growth, hyperactivity, impaired hearing, and at very high exposure levels, even brain damage (4). Lead has the greatest effect on the nervous system, especially in children. In children, low levels of lead can cause weakness in fingers, wrists, or ankles. Unborn children can also be exposed to lead through their mothers and are at risk of premature births, low birth weight, decreased mental ability, learning difficulties, and reduced growth as young children (4).

Studies have shown that there is a definite correlation between concentrations of lead in soils and blood lead levels in children. In general, blood lead levels increase as the lead concentrations in soil and dust increase. As blood lead levels increase, the likelihood of adverse health effects also increases. The primary health risk of concern due to ingestion of lead contaminated soil in Barry County is the effects lead has on the nervous system, which may lead to learning difficulties and behavioral problems.

Yearly blood lead testing before a child is 72 months old is key in determining if the child has been exposed to lead. Eliminating exposure pathways by controlling contamination sources, practicing good personal hygiene, and eating a proper diet high in calcium can reduce the risk of lead poisoning in children.

CONCLUSION

In communities where hazardous chemicals exist, DHSS, along with ATSDR, work to ensure that the community has the best information possible to safeguard its health. In Barry County, historical information shows evidence of heavy metal mining in some areas. Environmental samples collected in this area by EPA and DNR have prompted us to make the following conclusions:

- During DNR's sampling, they found one private drinking well with concentrations of cadmium above a level of health concern. Because of this, DHSS concludes that drinking water from this well for more than one year could harm people's health, especially children.

- DNR found one residential yard with concentrations of lead in the soil above a level of health concern. The concentration of lead in the soil was higher near the house which suggests that the source of the lead may be coming from the house possibly due to deterioration of exterior lead-based paint. Regardless of the source, this contaminated soil still poses a health risk. DHSS concludes that incidental ingestion of this lead contaminated soil for more than one year could harm people's health, especially children.

- One private drinking water well was found to have lead concentrations at the wellhead above a level of health concern. However, the residence has a water filter at the tap that is reducing the lead in the drinking water below a concentration of health concern. Because of this, DHSS concludes that drinking water taken from this filtered faucet will not harm people's health, so long as the filter is properly maintained.

- EPA tested a spring in this area in April 2006 and found lead concentrations over 15 times the level of health concern. DNR has tested this spring twice since April 2006 and found lead concentrations below a level of health concern. DNR has reported that this spring is not currently being used as a residential drinking water source. Therefore, DHSS concludes that water from this spring will not harm people's health due to lead because people are not drinking it.

RECOMMENDATIONS

1. DNR should continue to identify and sample private yards and wells located near former mining sites to determine if elevated levels of lead or other contaminants are present.

2. Individuals with elevated concentrations of cadmium in their drinking water should start drinking bottled water or filter the water before drinking, especially for children. In addition, these individuals should reduce their exposure to other sources of cadmium such as smoking.

3. DHSS recommends blood lead testing for pregnant women and yearly testing for children under the age of 72 months to determine if they have been exposed to lead.

4. DHSS recommends homeowners whose private drinking wells have been identified by DNR as having elevated concentrations of lead to take steps to limit their exposure to lead. This can be done by drinking bottled water or installing and maintaining a water filter that is designed to remove lead.

5. DHSS recommends homeowners take steps to limit access to lead in soils in the areas of the yards identified by DNR as having lead contamination. Some examples of the many different ways a homeowner may accomplish this are by establishing a vegetative cover over the area; covering the areas with several inches of clean soil, pea gravel or pavement; removing the contaminated soils; or other methods to reduce exposure.

6. DHSS recommends that gardens not be placed in areas found to have elevated lead concentrations. If gardens are placed in areas with elevated lead concentrations, individuals should consider reducing the use of root crops and leafy vegetables and give planting preference to fruiting crops.

7. DHSS recommends that children's play areas not be placed in locations found to have elevated lead concentrations. Instead, placing children's play areas away from contaminated areas may encourage children away from the contaminated areas.

PUBLIC HEALTH ACTION PLAN

This Public Health Action Plan (PHAP) for Barry County contains an explanation of the actions to be taken by the Missouri Department of Health and Senior Services (DHSS), the Agency for Toxic Substances and Disease Registry (ATSDR), and other stakeholders. The purpose of the PHAP is to ensure that this public health consultation not only identifies public health hazards, but provides an action plan to mitigate and prevent adverse human health effects resulting from past, present, and future exposures to hazardous substances at or near the site. Below is a list of commitments of public health actions to be implemented by DHSS, ATSDR, or other stakeholders at the site:

1. DHSS/ATSDR will continue to address community health concerns and questions as they arise.

2. DHSS/ATSDR will provide educational materials and training to individuals in Barry County regarding metal contamination when requested.

3. DHSS/ATSDR will review and comment on any additional data from environmental samples collected by EPA, MDNR, or other agency as it becomes available.

CERTIFICATION

The Missouri Department of Health and Senior Services (DHSS) prepared this Heavy Metals in Barry County Health Consultation under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR). It was completed in accordance with the approved methodologies and procedures existing at the time the health consultation was initiated. The Cooperative Agreement partner completed editorial review.

Technical Project Officer, CAT, CAPEB, DHAC

The Division of Health Assessment and Consultation (DHAC), ATSDR, has reviewed this health consultation and concurs with its findings.

Team Lead, CAT, CAPEB, DHAC, ATSDR

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